VISIONS 2000

A Vision of Educational Technology in Alberta by the Year 2000

Alberta
EDUCATION
1987

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By the Year 2000

A Discussion Paper
by
Technology in Education Committee
Student Programs and Evaluation Division
Alberta Education

May 1987

ACKNOWLEDGEMENTS

The Technology in Education Committee was established in April 1986 under the direction of the Assistant Deputy Minister of the Student Programs and Evaluation Division. The Chairman wishes to acknowledge and extend his appreciation to the members of the committee for their contributions to this Vision Paper.

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A special acknowledgement is extended to Ian James and Wolfgang Schimeck for their efforts in developing drafts of this Vision Paper for committee reaction.

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I. MANDATE AND ACTIVITIES OF COMMITTEE

The Technology in Education Committee was established in April 1986 with a mandate requesting that it:

1. conduct an analysis of the Secondary Education Policy Statement (1985) and identify the technology initiatives recommended;

2. initiate developmental activities regarding policy, background information, definitions, literature surveys, and recommendations;

3. develop a policy and definition for technology in education;

4. develop recommendations for action and implementation regarding technology in education.

To accomplish these tasks the committee has met on eighteen occasions and retained an external consultant to research and prepare draft reports. Committee activities have included numerous meetings with Alberta Education resource persons as well as the review, analysis, and discussion of selected documents; preparation of an Action Plan; preparation of a Vision Paper; preparation of a Technology Background Paper; preparation of a Curriculum and Technology Integration Paper; and a survey of Alberta Education technology policies.

This Vision Paper was the result of a meeting between the committee, the Deputy Minister and the Assistant Deputy Minister of Student Programs and Evaluation. Redrafts were prepared as a result of reactions by the Assistant Deputy Minister of Student Programs and Evaluation and the Director of Curriculum. Additional redrafts were prepared as a result of suggestions by Management Council of the Student Programs and Evaluation Division (March 23, 1987) and Educational Officials (May 19, 1987).

The Vision Paper is written as the committee's vision of educational technology in Alberta by the year 2000 and as such is minimally footnoted. The background paper "Educational Technology in Alberta" contains detailed research references for those readers interested in obtaining more specific information on the sources used in the preparation of this Vision Paper. Copies may be obtained from the Chairman.

II. INTRODUCTION

This Vision Paper has been developed by the Technology in Education Committee and is based, in part, on numerous documents the committee reviewed from Alberta, national and international sources. Of particular interest were the following reports:

1. "Towards the Year 2000: Future Conditions and Strategic Options for the Support of Learning in Ontario." Ontario Ministry of Education, Toronto, 1984.

2. "Time for Results." The Governors' 1991 Report on Education, Task Force on Technology Report, National Governors' Association Center for Policy Research and Analysis, Washington, D.C., 1986.

3. "Transforming American Education: Reducing the Risk to the Nation." A Report to the Secretary of Education, United States Department of Education by the National Task Force on Educational Technology, Washington, D.C., 1986.

4. "Information Technologies and Basic Learning: General Report." Organization for Economics Co-operation and Development, Paris, 1986.

5. "Information Technologies and Basic Learning: Reading." Organization for Economic Co-operation and Development, Paris, 1986.

6. "Information Technologies and Basic Learning: Arithmetic and Mathematical Concepts." Organization for Economic Co-operation and Development, Paris, 1986.

7. "Information Technologies and Basic Learning: Scientific and Technological Concepts." Organization for Economic Co-operation and Development, Paris, 1986.

8. "Information Technologies and Basic Learning: Written Expression." Organization for Economic Co-operation and Development, Paris, 1986.

9. "Horizon 95: Prospective sur les technologies de l'information et leur impact sur le système educatif." Ministère de l'Éducation, Montreal, 1986.

10. "Toward the Year 2000: Future Directions in Curriculum and Instruction." Saskatchewan Education, Regina, 1985.

Alberta schools have traditionally used technological tools such as radio, film, television, audio cassettes, filmstrips and, more recently, microcomputers, laserdiscs and video cassettes to supplement teaching.

- In the 1950s Alberta led Canada in the purchase and use of filmstrips and was a leader in 16mm films.

- In the 1960s Alberta pioneered the use of educational television in both broadcast and video modes.

- In the 1970s Alberta established a Crown agency for the acquisition, production and distribution of multi-media learning resources.

- In the 1980s Alberta led all of Canada and all but three American States in the provision of microcomputers to schools, and in the evaluation of computer software.

- TODAY, Education in Alberta has an "installed" base of technological tools that includes:

  * 27,000 microcomputers;
  * a satellite television distribution system;
  * five regional and five urban film centres;
  * an AM/FM radio network;
  * an average of 2 radios in over 80% of schools;
  * an average of 9 audiotape recorders in over 98% of schools;
  * an average of 2 television receivers in over 93% of schools;
  * an average of 3 film projectors (16mm) in over 98% of schools; and
  * an average of 7 overhead projectors in over 98% of schools.

While the work of the committee is not complete, this Vision Paper is intended to initiate discussion and action regarding educational technology in Alberta and provide an umbrella vision for a number of technological activities Alberta Education is and could be undertaking. In this respect the Vision Paper is consistent with:

- the Secondary Education Policy Statement.
- the Alberta Education Four Year Plan (February, 1987; Revision #1, March, 1987).
- the Strategic Plan for Microcomputers in Schools (February 2, 1987).
- the Computers in Elementary Education Discussion/Directional Paper (February, 1987).
- the School Libraries Policy.
- the Regional Film Centres Policy.

The Technology in Education Committee believes that there is ample evidence that by using our technological tools in a major, systematic way we can supplement and enhance teaching and learning and also enable teachers and students to be more efficient. However, much more work is required, particularly with respect to implementing educational technology throughout the school curriculum. The vast potential of educational technology, combined with present fiscal restraints, presents Alberta Education with a unique leadership opportunity: it is a challenge we cannot afford to ignore.

Wayne Blair
Chairman
Technology in Education Committee

May 1987

III. EXECUTIVE SUMMARY

Research has led us to a vision of a future where individual needs of each student can be met by our educational system in new and powerful ways. Study after study indicates the importance of an intelligent application of technology to the provision of learning opportunities for children.

Our vision of the year 2000 is one of rich and responsive environments for learning where each child may develop confidence and competence in using twenty-first century tools to deal with changing challenges that will call for new attitudes and skills to meet new personal and social realities.

The future is never as far away as we think it is, and there is a sense of urgency in the reports we have surveyed. This urgency stems from the increasing rate of change, the ever more complex nature of life in a technological society, and the opportunity to exploit the technologies that have such a major impact on virtually every other aspect of life. We see a future where students understand that technology is as much a consideration of ends as it is of means and whose level of understanding matches the sophistication of the technological tools at their disposal. We see technology pursued not as an independent goal, but as a means to achieve educational ends such as the general vision set forth by the Secondary Education Policy Statement and Alberta Education's Four Year Plan: 1987-1990.

Imagination and creativity are uniquely human qualities that can be liberated by technological literacy and the new ways of thinking that technology makes possible. Only through being comfortable and familiar with technological change can we hope to understand it and use it to cope with the dramatic and often disturbing pace of change.

Technology can be a critical component of the teaching-learning process and offer new opportunities for effectiveness if we allow it to play a full and appropriate role in the educational enterprise. Research findings clearly indicate substantial savings of time and cost in achieving learning objectives. There is a very real potential for freeing students and teachers alike from a lock-step approach to learning. There is a very real potential for managing and delivering learning opportunity geared to the needs of each individual and of freeing teachers from some of the repetitive chores of imparting information and administering the system. In this sense, technology can be applied creatively to bring a new quality of human interaction to those crucial moments where humans perform incomparably well.

Our vision supports the fundamental spirit and intent of the Secondary Education Policy Statement which identified technology as an important component of the management and delivery of educational programs, both in the classroom and for distance education. Throughout our deliberations we have borne in mind the call for equitable access to learning opportunity, the greater individualization of learning, and the development of lifelong autonomous learning skills called for in the Policy Statement. There is no question that technology, intelligently applied, can enhance the quality of learning at fixed or reduced levels of funding, particularly in small or remote schools.

In implementing improved technological systems in Alberta's schools we believe that the limitations of technology and impediments to change must be analyzed with care. It is critical to effective implementation that we consider all the variables--humans, materials and machines—and plan for a future where all variables are managed to create the optimum use of all resources. In a sense, this is the true definition of any technology; it is especially important in education where it is imperative that we create environments that are humane.

Our assessment of past and present uses of technology in education leads us to great hope for future systems because there is sufficient maturity to plan for effective implementation. Alberta's teachers already make effective use of a relatively well-endowed inventory of equipment and materials. However, further realization of the potential of technology must be based on significant re-allocation of funds to the raw materials of learning. We do not hesitate in recommending this re-allocation because the evidence is compelling.

Research indicates that effective application of technology will:

1. Make education more productive.
2. Make education more immediate and relevant.
3. Make education more powerful.
4. Give instruction a more scientific base.
5. Make education more individual.
6. Make education more accessible.
7. Make education more responsive to special and individual needs.
8. Make education more cost effective and efficient.

In terms of the curriculum itself, technology should be integrated into all courses of instruction so that students will learn:

- about technology
- in technology
- through technology

Our vision of the teaching-learning process in the future is based on a fairly obvious division of labour where teachers can function in those uniquely human areas of diagnosis, prescription, motivation and overall management of the learning process for individuals and groups of various sizes while technology can play a greater part in exposition, simulation and information retrieval and processing. This process will involve students in regular use of these facilities:

1. Individual students will work extensively with a computer-based workstation and access a wide range of instructional software, productivity tools, and information from local and remote databases. This will be part of a school local area network and capable of linking to a wide area network.

2. Students will have access to a portable computer having much the same capabilities as the school computer so that work can be accomplished in the home, in the community, or any other place.

3. The hub of the school local area network will be a computer system containing instructional software, a number of highly used databases, and a sophisticated computer-managed learning system for managing individualized instruction. The system will be connected to the school board computer for records, evaluation, etc.

4. The school will be equipped with satellite transmitting and receiving technology. The system will allow the school to acquire learning resources, receive direct signals from a variety of sources, and transmit information and courses to students elsewhere.

5. Holography will be used widely, coupled with the artificial intelligence capabilities of the new generation of computers.

6. Through technology, students will have access to a variety of information sources and work autonomously with primary sources.

7. Technological tools such as lasers, robotics, music synthesizers and a variety of computerized and electronic equipment will be available for school use in a wide range of subjects and at all grade levels.

The increased use of technology will develop improved technological literacy on the part of students and teachers and create a diversified learning program that meets individual and group needs in a more efficient, effective and responsive way. Appropriate pre-service and in-service education will permit a more balanced and judicious use of technology to create rich and responsive environments for learning inside and outside the confines of traditional 'schooling'.

The need for an action-oriented plan is urgent. Since the times call for "doing more with less", we are confident that technology can play a vital role in improving the quality of education.

IV. A VISION OF EDUCATIONAL TECHNOLOGY IN ALBERTA

1. INTRODUCTION

The Technology in Education Committee's review of the research confirms the judgment of the Secondary Education Policy Statement that technology is an important component of management and delivery of educational programs, both in the classroom and for distance education. The Secondary Education Policy Statement contains a number of other key policy directions that serve as the foundation of the mandate of the Technology in Education Committee:

- The secondary education system must use technology to enhance learning and to facilitate access to equitable educational opportunities for all students regardless of ability, circumstance, or location. (Page 8)

- (Schools) are to assist students to...assume increasing responsibility for independent and continuous learning, and develop positive attitudes towards learning while in school, in preparation for self-directed, lifelong educational experiences. (Page 13)

- Secondary schools should ensure that students have access to adequate information services and develop information retrieval and other related skills essential for independent and lifelong learning. (Page 15)

- The knowledge, skills and attitudes relevant to advances in technology and its utilization will be integrated into secondary school courses wherever appropriate. (Page 16)

- Besides facilitating distance education, new technologies may support greater individualization of some learning activities. (Page 16)

- In addition to assisting students with routine learning needs, distance education offers the potential for catering to the particular needs of students with special abilities or interests. (Page 16)

Although the Policy Statement contains numerous additional references to the potential use of technology, the six statements above are seen as crucial to the development and implementation of a vision of education in the year 2000.

We endorse the general directions set forth in the Secondary Education Policy Statement. We believe that the emphasis on lifelong learning, individualized instruction, innovative and creative thinking, and broadened, equitable opportunities for learning constitute Alberta's best hope for meeting the challenges of the future. We also believe that technology will play a vital role in achieving the goals advanced by the Policy Statement, particularly for small and remote schools which have traditionally laboured under serious handicaps in the areas of human and material resources. Our research has led us to these basic assumptions concerning the nature of education, technology and the future:

a) The learning needs of students will have primacy in the integration of technology in education.

b) Schooling should and will continue to exist as a major instrument of socialization and education. The structures associated with schooling will be much the same as those currently in existence.

c) The reallocation of resources, including technological resources, can enhance the quality of learning at comparable or reduced costs.

d) Adoption of existing and emerging technologies can increase the effectiveness of individualized learning and provide new opportunities for widespread use of learning systems, both inside and outside the school.

e) The transition to a more effective and efficient system of education will be evolutionary rather than revolutionary.

f) Technology can play an especially important role in the teaching of the essential skills which require competence in the management of information.

g) Successful implementation of technology in education will require a longer-term planning and budgeting period than is currently the case.

h) Curriculum design and development should be based on the integration of objectives, content, and technology, using a multi-disciplinary team approach.

i) Computer technology will play an increasingly important role in all aspects of education, and integrated circuits will provide new opportunities for information technology and education.

j) The effective integration of technology in education will depend on the establishment of a relationship among people, materials, and machines which recognizes the strengths and limitations of each. Teachers will continue to play a key role in the teaching/learning process.

These assumptions provide the basis for the vision and strategies outlined in this paper.

2. THE FUTURE

> "If educators are to chart our educational future, they must move from reality to vision. Today's educators must have the temerity to move from the study and recording of today's happenings to the creation of tomorrow's possibilities. Creativity, vision, and bold imaginings are also the keys for the development of educational futures."[1]

Predictions of the future are inevitably difficult and often inaccurate in their specifics; however, if we are to create the kind of educational system that will equip students to deal with an accelerating rate of change, we must start now. This is the message of the Secondary Education Policy Statement, and it is the message of the research findings contained in our Background Paper.

Adaptation of organizations and individuals is imperative because there is strong evidence that present structures will have difficulty in coping with even the more conservative views of the future.

While it is true that the present educational system has served the industrial society well, it is equally true that our society is undergoing considerable change - that it is in fact evolving into a significantly different form. Such an evolution will require nothing less than the transformation of education if we are to meet the needs of our students.

Education has historically resisted rapid change. Any attempts to transform the educational system must be rooted in a thorough understanding of the role that schools play in society. Major social institutions, of which education is one, achieve their status not by challenging the underlying principles of society, but by supporting them. The only practical reason for changing schooling, and the only one with any hope of success, is because society itself is changing. Naisbitt and Toffler are but two of the many authors who have documented the impact of the "information age" on our economic and social structures.

Rather than being involved in the production of goods, most modern workers are occupied in the production, storage manipulation, and distribution of information, knowledge, and services. The remaining minority of blue-collar workers is rapidly being replaced by machines, and whole occupational classifications are becoming extinct. Developments in the related fields of robotics and computer-assisted manufacturing have given rise to a new occupational class - the "steel-collar" worker. Robots and other automation technologies have the potential to increase productivity and improve production quality, but they also pose serious questions regarding issues such as unemployment. Dr. Carl Hammer[2] points out that 75% of the work force of the year 2000 is already employed and that 90% of that work force will be information workers. These figures suggest that most workers can expect to have several different jobs during a lifetime, and that they will require skills in independent and lifelong learning.

Taken together, rapid technological change and the uncertain international political/economic climate have made predicting the future with a high degree of reliability extremely difficult. However, a number of major trends have emerged which make it possible to suggest some of the significant changes which will reshape society by the turn of the century.

a) Information is becoming both the "capital" and the chief "product" of the new industrial society. At the same time, there is an increasing disposability of information and an increasing obsolescence in what we have learned.

b) People are losing confidence in the ability of traditional institutions and ideologies to cope with the complex problems facing modern society.

c) The time between the invention and the application of a particular technology is shrinking to the point of non-existence, leading to what the Club of Rome has termed the "human gap", the growing difference between the complexity of our technological environment and our human ability to understand it.

d) Citizens of the industrialized nations will live in a technology-rich environment in which both the workplace and the home will feature a great degree of reliance on electronic means of production, communication, entertainment, and learning.

3. A VISION OF EDUCATION BY THE YEAR 2000

> "That is the biggest challenge – the challenge of ensuring that all our youth have opportunities to learn, to grow, and to develop into productive, competent, confident and responsible young adults."[3]

The graduate of the year 2000 has already entered an early childhood program and will emerge a short 13 years from now to enter a changed and changing world. If we examine current and future trends, it is obvious that the graduates of the year 2000 will need to be flexible and adaptable and that they will need a high degree of tolerance for ambiguity and change. In addition, it is very likely that they will require skills in new ways of thinking, decision making, and coping with new and unfamiliar hierarchies and social structures.

The Technology in Education Committee identified two documents that contribute to the vision of education in Alberta by the year 2000. These documents are the Secondary Education Policy Statement and Alberta Education's Four Year Plan: 1987 to 1990.

The Secondary Education Policy Statement contains a number of indicators to the future – indicators that are directed towards secondary education but are also applicable, in a general sense, to elementary education. The policy statement sets the direction, goals and priorities for the future, with an early impact on education in the late 1980s and full impact in the 1990s. For example, the goals of secondary education are to assist students to:

- develop the ability to think conceptually, critically and creatively, to acquire and apply problem-solving skills, to apply principles of logic, and to use different modes of inquiry
- master effective language and communication skills, including the ability to use communications technology
- acquire basic knowledge, skills, and positive attitudes needed to become responsible citizens and contributing members of society
- learn about the interdependent nature of the world, through a study of history, geography, and political and economic systems
- become aware of the expectations, and be prepared for the opportunities of the workplace – expectations that will be faced as employees or employers; expectations that will be faced as entrepreneurs or volunteers
- assume increasing responsibility for independent and continuous learning, and develop positive attitudes towards learning while in school, in preparation for self-directed, lifelong educational experiences
- learn about themselves and develop positive, realistic self-images
- develop constructive relationships with others based on respect, trust, cooperation, consideration and caring as one aspect of moral and ethical behaviour
- develop cultural and recreational interests and realize personal aspirations.

The central focus of the policy statement is the student, with the recognition that the key to an excellent education lies in the positive and rewarding interaction of students and teachers.

Alberta Education's Four Year Plan: 1987 to 1990 contains a number of additional indicators to where education could and should be in 1990. In summary, the future is described in terms of:

- improved student learning
- increased equity
- enhanced flexibility
- improved responsiveness and efficiency
- clarified roles and responsibilities

Review of research, current trends, and the insights in the aforementioned documents, has led us to a vision of education in Alberta by the year 2000 that is one of rich and responsive learning environments that will assist each student to acquire and develop the knowledge, skills and attitudes required for effective living.

We endorse the general vision of education set forth by the Secondary Education Policy Statement and Alberta Education's Four Year Plan: 1987 to 1990. We believe that the emphasis on lifelong learning, individualized instruction, innovation and creative thinking, and broadened, equitable opportunities for learning constitute Alberta's best hope for meeting the challenges of the future.

We also believe that technology will play a vital role in achieving the vision advanced by the Secondary Education Policy Statement and Alberta Education's Four Year Plan: 1987 to 1990. We see that,

> "The greatest promise of technology is that it has the capacity to manage and deliver learning geared to the needs of each student. Through its range and power, technology – based education can promote the transformation in quality and quantity that education will need to achieve in the years ahead."[4]

We see students who understand that the intelligent application of technology is as much a consideration of ends as it is of means, and whose level of understanding matches the sophistication of the technological tools at their disposal.

It should be noted that many visions of education in the future tend to focus on learners interacting with computers in relative isolation. What we envision is a flexible approach that allows the teacher, as a "learning manager", to assess the needs of students and marshall the required resources to meet those needs. We see technology pursued not as an independent goal, but as a means to achieve educational ends such as the general vision set forth by the Secondary Education Policy Statement and Alberta Education's Four Year Plan: 1987-1990.

4. A VISION OF TECHNOLOGY IN EDUCATION BY THE YEAR 2000

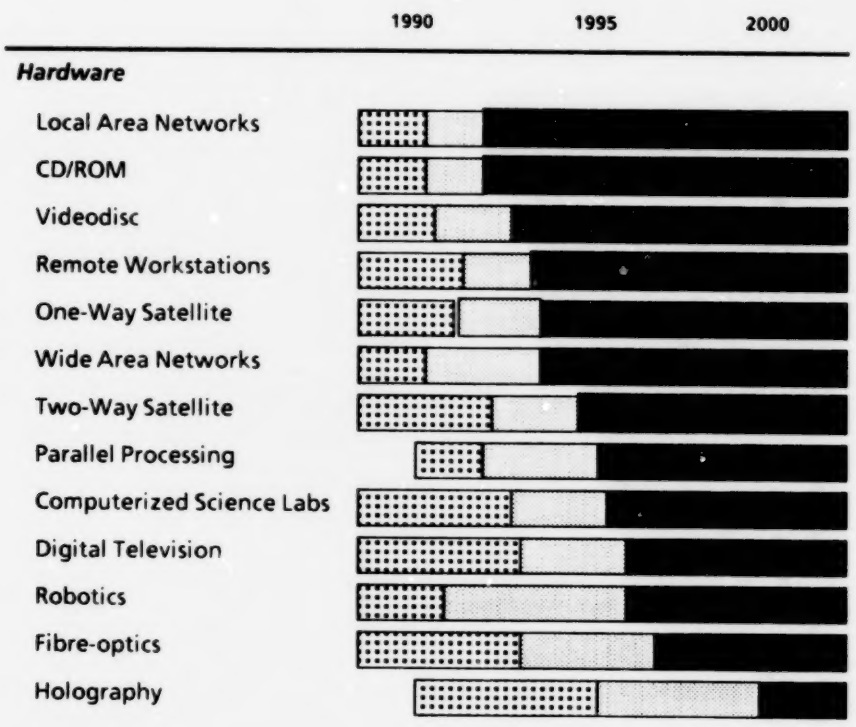
> "Teachers dream of being able to truly 'reach' each student. We fantasize that we might be able to compensate for the diverse intellectual needs and the many incongruous learning styles that face us each day. If only we could find a way to put each learner truly 'in charge' of his or her own learning! Believing that the full realization of one's potential as a citizen in the twentieth century requires a personal commitment to a lifetime of learning, we accept as education's ultimate goal the development of each student's potential to become an effective, independent learner."[5]

Although technology is advancing at such a rapid rate that accurate predictions are hazardous, the following are conservative estimates of the technological assets which will be at the disposal of educators and students within the next ten to fifteen years:

- Virtually every home and school will be equipped with digital television and either a high-resolution videotape machine or a recordable videodisc player.
- Home and school computers will feature high-speed processing, probably parallel processing, large amounts of memory in excess of 100 megabytes, data storage capacity measured in gigabytes, built-in local and wide-area networking capability, and interfaces to videodisc players and other peripherals.
- Two-way satellite communication systems will be within the reach of every school and quite a large number of households.
- Full text database systems will be available either through on-line searching or through a subscription service via compact disks/read only memory (CD/ROM).
- So-called expert systems (artificial intelligence) will be available for specific applications on school computer systems.
- High resolution holographic projection systems will be affordable by schools.

Predictably there will be major innovations in the next 13 years which can have major impact on education, both in school and in the home. A conservative estimate of when these might be available for widespread use is outlined below:

EDUCATIONAL USE OF NEWER TECHNOLOGY



Acronyms

CD/ROM Compact Disc/Read Only Memory

For the first time we are in a position to make extensive use of the technologies which permeate virtually every other aspect of our society and to construct an educational system which enhances opportunities for learners and brings a new level of effectiveness to the teaching-learning process. In the near future technology-based systems will create this type of scenario:

- Individual students will work extensively with a computer-based workstation which can access a wide range of instructional software, productivity tools, and information from local and remote databases. The workstation will be capable of drawing on videodisc and CD/ROM libraries for audio, visual and text information. The system will be part of a school local area network and will be capable of linking to a wide area network to provide electronic messaging and conferencing capabilities. Messages and conferences can be computer-based or they might employ the telephone or two-way video, but the computer will be the "traffic cop" which facilitates communication.

- Students will have access to a portable computer with many of the same capabilities as the school machine, so that work can be conducted at home or in community facilities.

- The hub of the school local area network will be a powerful central computer system which contains instructional software, a number of high-use databases, and most important, a very sophisticated CML (Computer Managed Learning) system. The last component will manage individualized instruction, keep track of student activities and achievements, perform the first level of diagnosis of student difficulties and learning preferences, and assist teachers in the provision of appropriate support to the student. The system will also be connected to the school board office computer for transmission of student records and marks and will be accessible from students' and teachers' homes.

- The school will be equipped with satellite transmitting-receiving dishes which can access signals from multiple satellites and transmit data to a number of locations. This system will allow the school to acquire new software, receive direct signals from a variety of sources, including special purpose sources such as geographic survey satellites, and to transmit information to students elsewhere in Alberta or the rest of the world.

- Holography will be widely used to augment two-dimensional audiovisual presentations as well as to illustrate ideas which require conceptualization in three dimensions. This technology, when coupled with the artificial intelligence capabilities of the new generation of computers, will promote the production of qualitatively different instructional programs and, when placed in the hands of the students, will foster the development of integrated communication skills.

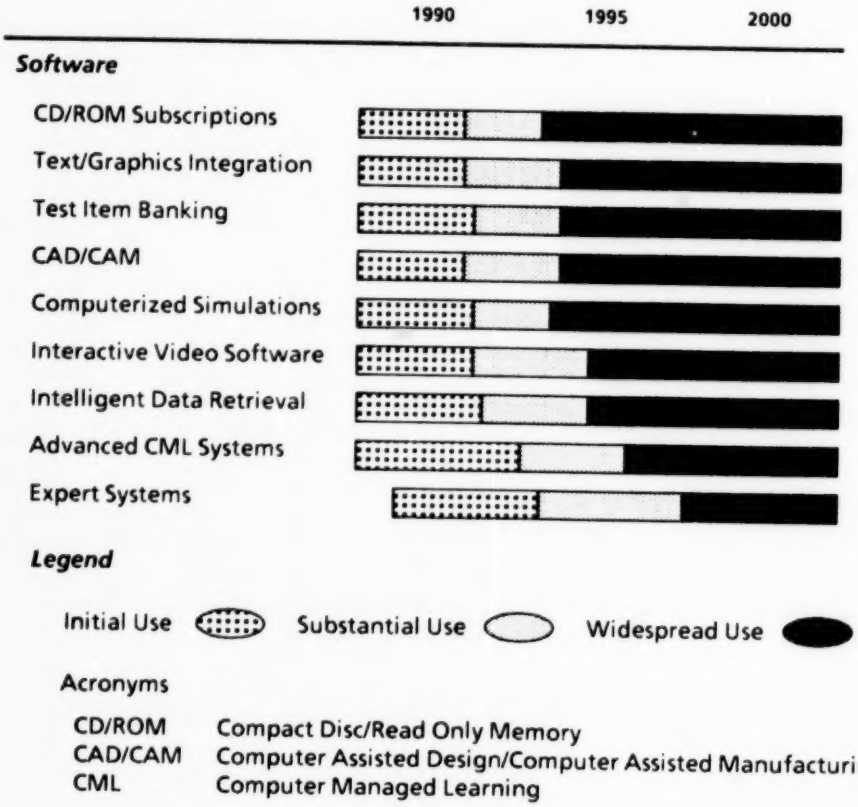
- In addition to technologies which function as communication and presentation devices, schools will be equipped with a wide range of other technologies, including:

  - robotics
  - lasers
  - computerized data acquisition equipment for science laboratories
  - music synthesizers which allow students to compose and arrange music and generate sheet music
  - CAD/CAM (Computer-Assisted Design/Manufacturing) systems
  - a broad range of other technological devices and systems for use in areas such as the practical arts.

- Students will have access to a variety of information sources, including formal and informal electronic conferences. These conferences will provide assistance with specific instructional problems, allow the exchange of information among students who are widely separated geographically, and permit student interaction with experts who would normally be unavailable for consultation within the school. For example, students of astronomy would be able to confer with recognized experts in such fields as space colonization.

The technologies listed above will employ vastly improved programs and software, enabling users not only to perform current tasks more effectively, but also to employ technology for completely new applications. These advances will be accompanied by trends toward miniaturization, increased "user-friendliness", and most importantly, significantly lower costs. In the immediate future we see the following software technologies being available and in use by the year 2000:

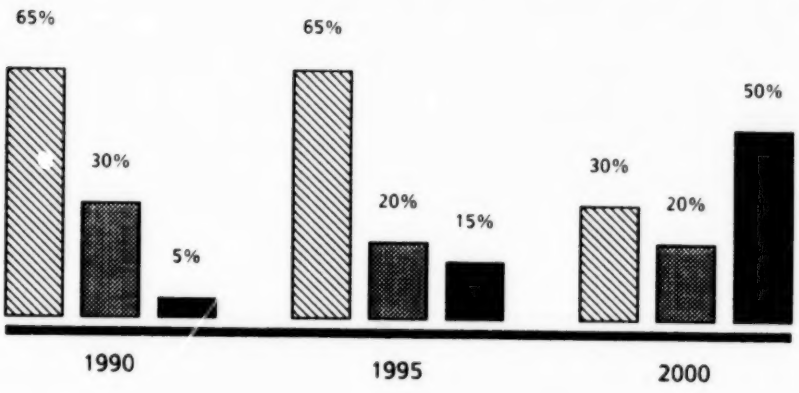
EDUCATIONAL USE OF NEWER TECHNOLOGY



There will probably be a fairly obvious division of labour between machines and humans in the teaching-learning process, with machines providing the vast majority of the data and information, and some of the higher level analytical functions. People will concern themselves with the development of knowledge and wisdom and with the critical human interactions that can make schooling a personalized experience. This process will be learner-centered, and will take into account the learning styles and preferences of individual students.

One of the major deterrents to offering a truly individualized program is the formidable amount of diagnostic work, record-keeping and administration involved for teachers who generally have too little time to undertake this work. It is precisely in this area that technology can offer extensive help to teachers. Computer managed learning programs, carefully designed learning systems, and intensive provision of resources can allow teachers to concentrate on the critical professional roles of motivating, tutoring, guiding and planning. Technology can offer very real promise in making teacher time more productive, more human, and more effective.

TEACHER ROLE AS A FUNCTION OF TIME



LEGEND

Group Instruction

Discipline and Administration

Individualized Teaching/Facilitating

It should be noted that many visions of education in the future tend to focus on learners interacting with computers in relative isolation. What we envision here is a flexible approach which allows the teacher, as a "learning manager", to assess the needs of students and marshall the required resources to meet those needs. The technology-based system envisioned here would support:

- classroom instruction
- independent study, whether in the school, the home, or elsewhere in the community
- small-group study where members of the group need not be in geographical proximity

Information will be delivered in print, sound, still and moving pictures, computer graphics, holograms and, of course, in combinations of these media. The sources of the information will be much more diverse than is presently the case. For example, students of geography will have direct access to satellite mapping signals.

We feel that a technology-rich educational system is our best hope for achieving the goals set forth by the Secondary Education Policy Statement, of meeting the individual needs of the learners, and of responding intelligently to the quantitative and qualitative changes taking place in our society. We believe that the eventual transformation of the educational system can best be achieved through carefully chosen incremental steps, based on a thorough understanding of both technology and learning.

5. EDUCATIONAL TECHNOLOGY AND LEARNING

> "But for long-term survival, particularly in times of turbulence, change, or discontinuity, another type of learning is even more essential. It is the type of learning that can bring change, renewal, restructuring, and problem reformulation - and which we shall call innovative learning."[6]

The educational system envisioned here will not come about as a result of simply adding equipment to the current system. Successful implementation will be based on an appropriate approach to technology, a thorough knowledge of learning, and an awareness that the teaching-learning process, the curriculum, technology, and the related political/financial/managerial issues cannot be considered in isolation. Rather, these areas constitute a complex and dynamic ecology which must be considered as a whole if we are to plan effectively for the twenty-first century.

Management of existing resources and services under the technology plan envisioned in this paper can ensure a new synergy. This synergy will yield enhanced cost-effectiveness and reduce the need for the infusion of "new" money.

Our analysis of the literature on the future and the broad directions for change outlined in the Secondary Education Policy Statement led us to develop two key definitions that will help to avoid the shortcomings of a piecemeal "tool" approach to the use of technology in education. All too often, an enthusiasm for a particular device has led to advocating the use of a single medium as the panacea for all educational problems. This was the case with programmed learning, educational television, and microcomputers.

a) Educational Technology

The committee's definition of educational technology embraces a management approach to the allocation of resources according to the appropriate contributions to be made by each component of the system. The definition proposed is:

> **Educational technology is the management of environments for effective learning through appropriate interactions among people, materials, and machines.**

This definition provides an essential framework for planning effective incorporation of technologies and defining roles for people, materials, and machines. It will assist in the analysis of teaching-learning styles, appropriate uses of technology, and the improvement of educational opportunity.

The imperative of educational technology is planning, rather than a focus on the individual tools which may be used. The critical relationships between and among people, materials, and machines can be designed to provide a range of learning environments best suited to the needs of individual learners.

b) Learning Systems

Design of learning systems is a rapidly emerging field of expertise in educational technology, and we see a future where their widespread use will lead to improved productivity and performance of the overall educational system.

> **A learning system is designed to create effective interactions between the learner and what is to be learned. It provides teaching and learning strategies, materials, experiences, support, and evaluation to promote learning.**

We see the design of learning systems being of critical importance to the effective utilization of technology in education. With a learner-centred approach, development teams of learning psychologists, content specialists, instructional designers, and others can develop units of study that maximize the contributions of a true technology of education. Ongoing feedback and evaluation can lead to improved quality and relevance in learning.

As materials and machines carry an increasing role in imparting information, people can be freed for more humane activities. Teachers can increase time devoted to diagnosing learning difficulties and prescribing remedial activities and materials. Students can proceed at their own rate in a more self-directed mode and acquire an increased sense of responsibility for their own learning.

Given a greater range of learning systems, teachers will be encouraged to employ a wider range of strategies and materials to meet the different needs of students. Correspondingly, students will be encouraged to develop those attitudes of discipline, persistence, and autonomy so essential for the growth of lifelong learning skills.

An emphasis on learning systems will encourage greater awareness of the importance of understanding the psychology of learning.

Recent developments in learning psychology indicate a substantial improvement in learning can be achieved through the teaching of "learning skills". Combined with a more individualized learning environment, technology can promote greater effectiveness and efficiency in education. Autonomous learning through self-directed study and effective learning systems can save substantial amounts of time for both teachers and students and make the shift from "teaching" to "learning" a reality.

Benjamin Bloom[7] has set the standard to be expected of learning systems as two standard deviations increase in learning. This has been accomplished through one-on-one tutoring when compared to conventional teaching. This two standard deviation increase in learning is the "2 Sigma" criterion and implies that the average tutored student achieves at a level above 98% of the students in conventional control groups. Improvements in attitude, interest, and time spent on-task are other significant advantages.

The challenge is to find ways of matching the "2 Sigma" performance through learning conditions that can be implemented in group instruction and are therefore affordable. The preliminary research findings indicate that the impressive "2 Sigma" gain has been achieved in at least six reported cases employing a management approach to the conditions for learning. This management of the learning environment is at the heart of our definition of educational technology and it is critical to the maintenance of quality education under reduced budgets.

In planning for a differentiated approach to learning where alternative modes and styles promote motivation, responsibility and lifelong learning, teachers require a greatly expanded range of learning materials to meet the individual needs of students.

The Club of Rome, in its report "No Limits to Learning: Bridging the Human Gap", identifies two types of learning; "maintenance" learning and "innovative" learning. Maintenance learning is concerned with the acquisition of fixed bodies of knowledge and fixed outlooks or attitudes. This type of learning is suitable for dealing with known or recurrent problems. Innovative learning, on the other hand, is concerned with anticipating problems and opportunities through such techniques as simulation, modelling, and forecasting. The distinction between these two types of learning provides a useful framework for developing those "critical and creative" thought processes called for by the Secondary Education Policy Statement.

The educational system envisioned in this paper supports a diversity of instructional modes and learning styles. Because of its wide range of information-processing capabilities, it is much more appropriate and powerful in prompting innovative learning than the traditional instructional system. However, educators must be aware that the introduction of technology on a large scale will have a major impact on curriculum, teachers and students.

If technology is to play as large a part in school as it does in life, we must start now to implement the transition to a more effective and efficient system of education. Research suggests that the effective integration of technology will:

a) Make Education More Productive

Even so simple an application as using an overhead projector to store mathematics lessons can save up to 20% of class time. Sophisticated computer based programs are now delivering increases of 10%-40% in learning effectiveness. With technologies now operating in combination, a new synergy is possible that can save time now spent in imparting content. Since the times call for "doing more with less", reallocation of funds to technology can enhance overall productivity.

b) Make Education More Immediate and Relevant

The dynamics of everyday events can come alive through intelligent use of broadcast technologies, telephone, and modem access to data banks. Electronic networks can provide up-to-date information at the moment of need and bring viewpoints from the community into the classroom.

c) Make Education More Powerful

Judicious use of motion sequences can motivate learning through a multi-sensory involvement. Heart surgery, volcanoes, distant events and locations - all can be recalled with a sense of power not easy to match with chalk and talk. Media represent stored units of energy which can be released at appropriate times for large or small group presentation. Simulation and gaming programs can bring a degree of reality to learning and actively involve the student in manipulating information and getting feedback on decisions made.

d) Give Instruction a More Scientific Base

Although teaching is as much an art as a science, the use of planned programs, often developed with hundreds of hours of preparation, can be used to provide uniformly high standards of presentation. New teaching techniques can be readily incorporated into new learning systems and ensure a "fast track" for the findings of educational research.

e) Make Education More Individual

One of the major constraints to offering a diverse set of individualized learning experiences is the shortage of available materials and the tedious nature of testing and record keeping. Here, technology can make perhaps its most significant contribution. Motivation, built-in competency testing and feedback after diagnosis of the learning problem, and automatic record keeping are all features of computerized programs. Immediate reinforcement and learner choice can lead to self-directed learning and a responsive environment which respects the student and in turn is respected by the student. Improved personalization and humanization of learning can be achieved by freeing the teacher for truly human roles in diagnosis, prescription and tutoring. This integration of people, materials and machines can produce the ideal "High Tech - High Touch" vision advocated by Naisbitt.

In order for students to become lifelong learners and take more responsibility for their own learning, they have to learn by doing. Here, the developments in the field of distance education have made intelligent use of a variety of technological systems. These materials could serve as valuable alternatives to traditional modes of delivery and styles of learning.

f) Make Education More Accessible

Technology can collapse distance and provide new opportunities for the long distance learner. Also, these techniques can be readily adapted to diversify program offerings at lower cost than traditional systems. Electronic networking by audio, video, and/or computer conferencing can make substantial new contributions to education.

Electronic communications can be used to "gather" a whole class by taking two or three students from a number of locations and assembling them into a viable class that is cost-effective. Interactive capability provides tutorial assistance and pacing that minimize dropout rates and provides a social environment for interaction that minimizes the loneliness of the long distance learner.

g) Make Education More Responsive to Special Needs

Highly specialized programs for the deaf, blind, learning-disabled and gifted can employ the highest expertise available and relay a quality system anywhere in the province to those in need. Increasingly, technology is demonstrating a new power of outreach to small specialized audiences. Increasingly, multicultural and multilingual demands are being placed on the educational system and technology can be used to import quality materials. As new special needs emerge, technology can be deployed very rapidly to address these new priorities and provide a quicker response.

In the past, technology has been grafted on to the existing system and has been additive. We believe that substantive integration of technology must be based on a reallocation of resources and the realization that technology can in fact be used to maintain or reduce costs while increasing effectiveness. Typically, technology is capital intensive at the front end with long-term savings being realized over time.

Costs of technologies like teleconferencing, computers and satellites are declining while traditional delivery costs seem to be increasing. However, only if technology is used to subtract from the other component costs will the full potential be realized.

In the future, we see experience with whole segments of new curriculum being undertaken by technology based systems. Innovation in areas where there is a shortage of knowledge at the school level, lack of appropriate training, or shortage of quality texts, provides a target of opportunity for effective integration. This might lead to high school students spending increasing amounts of time in self-directed study of learning skills, career choices, selected vocational skills, etc. Identification and development of these segments might be undertaken by the Alberta Correspondence School. If increased funding for the raw materials of learning becomes a reality one might reasonably expect that other budget components would decrease over time.

Extensive research has demonstrated the ability of individual media or combinations of media to match or exceed the performance of traditional classroom-based instruction, usually in a more efficient or cost-effective manner. In addition, there is no doubt that media, when used outside the classroom, have had a powerful impact in shaping political, economic, and social behaviour. Information processing and communications technologies have been adopted by virtually every field of human endeavour except education, where these technologies play a distinctly peripheral role.

It should be obvious that the adoption of a technology-based educational system will have a tremendous impact on the nature of curriculum. Currently, curriculum is primarily content-oriented. In order to take full advantage of the technology, curriculum will need to be both process and content orientated an evolution which will be encouraged and facilitated by technology.

The Science Council of Canada and UNESCO have both urged a priority for developing technological literacy which not only educates in technology for technologists, but also educates those non-technologists involved in all levels of policy making. The Science Council calls for:

> "An emphasis and focus on the relationships of science, technology, and society in order to increase the scientific literacy of all citizens."

In Alberta, technology has yet to be thoroughly integrated into appropriate areas of the curriculum. There is no overall coordination and students in academic programs tend to get little exposure to technological concepts. A major problem in implementing effective technological literacy programs is the lack of appropriate learning materials. This problem is compounded by the fact that very few teachers have training or experience in the fundamentals of technology as content or as process.

Many teachers were born and trained before television; virtually all were born and trained in a time before widespread use of computers. Pre-service and inservice training in educational technology should be a is a major priority. Development and production of a university level learning system making full use of the technologies, and itself demonstrating a learner-centred approach to mastery, would be a first step.

We envision an integrated approach that ensures an appropriate and adequate inclusion of technology-related content in the different curriculum areas. On the point of teachers incorporating technology the Secondary Education Policy Statement is unequivocal:

> "The knowledge, skills and attitudes relevant to advances in technology and its utilization will be integrated into secondary schools wherever appropriate. An awareness of the advantages and limitations of technological developments, their impact on society, and the ability to use selected technologies to enhance learning and prepare students for current and future demands of society, are of such importance that all secondary school teachers will be expected to plan and incorporate this component into instructional programs." (Page 16)

Given that one of the primary goals of the Secondary Education Policy Statement is the development of technological literacy, students require experiences which will allow them to learn:

About Technology

to provide students with an understanding of the impact of technology on society in general and individuals in particular.

In Technology

to provide the "hands on" and theoretical familiarity required for further study and effective use of technology.

Through Technology

to make learning more efficient and effective by harnessing the instructional and information-processing capabilities of technology.

This section has summarized the potential contributions that technology can make to the improvement of learning. The research findings outlined in the Background Paper confirm that significant increases in cost-effectiveness can be attained by manipulating the variables which comprise the *conditions of learning*. This is consistent with the management approach recommended in our definition of educational technology. Increasingly, technology offers potential savings in time and cost when it is integrated effectively into the educational process.

However, it is critical that we understand the limitations of technology and the extensive change process required for effective integration. The implications for planning the future are critical and call for careful attention to:

- developing the required attitudes and skills in educators at all levels
- providing an effective supply of learning resources through local and provincial networks
- ensuring an adequate supply of equipment with the necessary maintenance and realistic budgetary procedures to allow for upgrading and replacement.

The committee believes that effective planning for the successful integration of technology must be based on a realistic allocation of resources. In times of fiscal restraint this becomes a question of **re-allocating** funds from existing patterns of expenditure.

Typically, technologies are capital-intensive when adopted, but significant achievement of cost-savings can be realized over a three to five year amortization. Few technologies used in education represent an expense greater than expenditures made in many individual homes for labour-saving and entertainment machines like washers, dryers, microwaves, television sets, stereos, vacuum cleaners, computers, etc.

At the school jurisdiction level, networks for education do not begin to approximate costs of networks established in other areas of society. It is only a fixed way of thinking about the role of technology in education that dictates that technology is "expensive". In use, most educational equipment like 16mm film, overhead projectors, VCR's, television sets, computers, etc., have a useful life of up to 15 years. In the context of about $50 per child annual expenditure on learning resources of all formats, we have no hesitation in recommending allocation of more funds for the raw materials of learning. After all, this is less than a family spends on a single newspaper subscription. The important distinction between capital and operational costs leads to the realization that educational technology is more often than not a cheaper way of offering the program in less time and with more effectiveness than traditional modes.

Naturally there are some areas where technology can be more cost-effective than in others, and there are some aspects of education where it is not appropriate at all. In these critical "teachable moments" where human interaction leads to very real break-throughs, no machine will ever compare with the power of people. Given an effective planning unit at the provincial level, it is possible to utilize technology judiciously and effectively to enhance the educational opportunities for all children. The price of not incorporating technology is much greater than the cost of incorporating it.

However, technology cannot deliver learning opportunity without effective integration and intelligent planning. There is still a critical shortage of high quality materials and this situation is likely to continue for some time to come. Pragmatically, the limitations of the machines themselves are a relatively minor constraint compared to our difficulty in planning and implementing effective utilization. Any plan must address the critical questions of software quality and re-training of people. Considerably more resources should be devoted to the software and people aspects of technology than to hardware.

V. CONCLUDING REMARKS

> "The policy context within which uses of technology for education must be considered is complex and includes forces which compete with each other and with efforts to achieve long-term improvements in education. There are a variety of economic and commercial considerations that must be taken into account, and there are also a variety of social and political concerns. The fundamental social contracts on which our society and its political systems are based have been placed in jeopardy by the recent and continuing explosion of technology and this has produced many strains."[8]

The industrial society which gave rise to the current education system is undergoing rapid change. The nature of work, the skills and attitudes required by workers, and the amount of information available to inform decision-making have all been significantly affected by technological developments.

The degree to which a society solves its problems is directly dependent on the amount of intellectual energy which can be focussed on them. The problems facing Alberta Society are trans-disciplinary in nature. To solve them, Albertans will require skills in innovative ways of analyzing, learning, and thinking. Such skills must be present in an increasing portion of the Alberta population, not only to deal with immediate problems, but to ensure the viability of representative government. A population which is unable to learn and to think creatively about problems will experience great difficulty in participating meaningfully in the political system. The Secondary Education Policy Statement recognizes this danger:

> "Secondary schools must prepare students for responsible citizenship in a society which is changing constantly. The best preparation for students to enable them to anticipate and shape the future is a broad general education with emphasis on critical and creative thinking, communication, personal development, science and technology, and an understanding of the community." (Page 8)

The challenge facing the Alberta education system is to respond to the needs of students in a rapidly changing society, to achieve the goals set forth by the Secondary Education Policy Statement, and to accomplish this in a climate of economic restraint. The thoughtful integration of technology in education holds the promise of meeting this challenge successfully.

Technology can improve access to information, encourage the development of independent learners, and provide instruction in an effective and efficient manner. It can also make teachers more effective by maximizing the amount of time they can spend on the important human interactions which are required to turn information into knowledge and wisdom and to individualize the learning experience. Finally, technology can realize these benefits with lower long-term costs than the current system of education.

Historically, the role of technology in education has been incremental and peripheral, with new technologies being added to the traditional teacher-centred model of instruction. This process has resulted in large expenditures and increases in teacher workload with no significant improvements to the performance of the education system. The true integration of technology requires a management approach which emphasizes planning the complementary and overlapping responsibilities of people, machines, and learning materials.

The Technology in Education Committee believes that there is ample evidence that by using our technological tools in a major, systematic way we can supplement and enhance teaching and learning and at the same time enable teachers and students to be more efficient.

The need for an educational technology action-oriented plan is urgent. Detailed implementation activities should support and integrate the positions taken in the Secondary Education Policy Statement, the Alberta Education Four Year Plan, the Strategic Plan for Microcomputers in Schools, the Computers in Elementary Education Discussion/Directional Paper, the School Libraries Policy and the Regional Film Centres Policy.

Since the times call for "doing more with less", we are confident that technology can play a vital role in improving the quality of education.

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